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## INTEGRATED CIRCUIT PACKAGE

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### Abstract

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**PURPOSE:** To obtain a highly reliable IC chip by a method wherein an insulator is installed between a lead frame and the IC chip so that the big-capacity and multifunctional IC chip can be used.

**CONSTITUTION:** An IC chip 2 is installed at a recessed part 106 which is constituted at an IC-chip mounting part 101 of a lead frame and a terminal lead 102; the IC chip 2 and the lead 102 acting as a terminal are connected by using a gold wire 3 by a wire bonding process; a package 10 for an integrated circuit is constituted after the whole assembly has been sealed by using a mold resin 4 by a transfer mold method, a casting method or the like. By this setup, even when the IC chip protrudes from the mounting part at the lead part, the IC chip does not become conductive to the lead frame and a malfunction of the IC chip is not caused.

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INTEGRATED CIRCUIT PACKAGE

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[There are no amendments to this patent.]

Claims

1. An integrated circuit package characterized by the fact that in the integrated circuit package constituted by sealing a lead frame and an IC chip with a molding resin in such a way

that the entire surface of the lead part of the lead frame is exposed on the surface of the package as the terminal after the IC chip is connected to the lead part, the IC chip is arranged on the lead frame via an electric insulator.

2. The integrated circuit package described in Claim 1 characterized by the fact that a concave part used for embedding the electric insulator or the electric insulator and the IC chip is formed on the aforementioned lead frame.

3. The integrated circuit package described in Claim 1 or 2 characterized by the fact that the aforementioned lead frame has a reinforcing part with respect to bending of the integrated circuit package.

#### Detailed explanation of the invention

##### Industrial application field

The present invention pertains to an integrated circuit package, especially an integrated circuit package mounted on an IC card.

##### Prior art

An integrated circuit package is usually comprised of an IC chip, a lead part used as an external terminal for connecting the terminals of the IC chip to the outside, a lead frame used for mechanically supporting the integrated circuit, and a package used as a housing formed by sealing the IC chip and the entire lead frame with a molding resin.

Because such an integrated circuit package is compact, allowing integrated circuits to be assembled at high density, and because it can be manufactured easily at low cost, it has been used for integrated circuits that require high assembly density.

In one of the integrated circuit packages developed in recent years, an IC chip is arranged in the mounting part of a lead frame. After the lead part of the lead frame is connected to the IC chip, the lead frame and the IC chip are sealed with a molding resin in such a way that the entire surface of the lead part is exposed as a terminal on the surface of the package. Such integrated circuit packages have been used for assembly of IC cards.

##### Problems to be solved by the invention

However, IC cards must meet the IC card specification (ISO/DP7816/2). If the specification is not satisfied, the IC card cannot be used in practical applications. When the aforementioned conventional integrated circuit package is used to manufacture an IC card that satisfies the specification, the size of the lead frame used for the integrated circuit package is limited by regulation of the "positions of the terminals on the card surface, and areas of the terminals" in the specification. As a result, the size of the IC chip set in the mounting part of the

lead frame is also limited, which makes it impossible to use multi-functional high-capacity IC chips. If an IC chip is used of such a size that it sticks out from the mounting part of the lead frame, it might electrically connect the IC chip and the lead part acting as the terminal of the lead frame to cause malfunction of the IC chip.

Also, since the thickness of the card main body specified in the specification is  $0.76 \pm 10\%$  mm, the integrated circuit package mounted on the card must be reduced in thickness to at least 0.76 mm or less. Since the integrated circuit package that satisfies the specification is so thin, cracks will develop in the molding resin that seals the package when it is bent.

#### Means to solve the problems

The purpose of the present invention is to solve the aforementioned problems.

The present inventors found that, if an insulator is placed between the lead frame and the IC chip in the integrated circuit package, the IC chip and the lead frame will not be electrically connected to each other even when the IC chip sticks out from the mounting part in the lead part and the IC chip will not malfunction. The insulator can also act as a package reinforcing part against bending. The present invention was achieved based on this research.

In other words, the present invention provides an integrated circuit package characterized by the fact that in the integrated circuit package constituted by sealing a lead frame and an IC chip with a molding resin in such a way that the entire surface of the lead part of the lead frame is exposed on the surface of the package as the terminal after the IC chip is connected to the lead part, the IC chip is arranged on the lead frame via an electric insulator.

In the following, the present invention will be explained in more detail based on figures.

Figure 1 is a partially cut-away oblique view illustrating an application example of the integrated circuit package disclosed in the present invention.

IC chip (2) is set via an insulator (1) in the concave part (106) formed in the IC chip mounting part (101) and terminal lead (102) of lead frame (100). IC chip (2) is connected to lead part (102) acting as a terminal with a gold wire (3) by means of wire bonding. The entire body is sealed with molding resin (4) by means of transfer molding or casting, etc., to form integrated circuit package (10). In the figure, (107) represents the molding resin filled in the space between lead parts (102), and (108) represents the molding resin filling the space between IC chip mounting part (101) and lead part (102). The package (10) shown in the figure has a rectangular shape formed by molding resin (4). The package, however, is not limited to this shape. The package may also be formed in a cylindrical shape or have the four corners rounded. The shape should be selected appropriately so that the processing can be facilitated when manufacturing the package and when mounting the package on a card.

IC chip (2) and lead part (102) can also be connected with a finger (5) by means of the tape carrier method shown in Figure 7. By using this method, the height of the wiring can be reduced compared with that in the wire bonding method, so that the thickness of the package can be reduced.

Figure 2 is a plan view illustrating an example of the lead frame used in the integrated circuit package of the present invention. A lead frame (200), used for manufacturing multiple lead frames (100) for the package units (the part encircled by the broken line in the figure) sealed by the molding resin, is constituted. It is preferred in manufacturing to use multiple lead frames (100) for the package units as the lead frame used in the present invention. However, if the manufacturing machine is unable to handle this, it is also possible to use one lead frame (100) for the package unit.

The lead frame (100) of the package unit comprises IC chip mounting part (101) used for setting IC chip in the central part and 8 lead parts (102) that surround said mounting part (101). In the present invention, an IC chip is set in part (106) (the area encircled by the dot-dash line in the figure) via insulator (1) and covers mounting part (101) and part of lead parts (102). Lead parts (102) are exposed from the resin surface, that is, from the back side of the package, when the lead frame is later sealed by the molding resin and act as terminals. However, the number of the lead parts is not limited to 8. It is also possible for them to be 6 depending on the function of the IC chip used. As shown in the figure, the width  $L_1$  of the part located at the edge of the package is smaller than the width  $L_2$  of the part located toward the center. In this way, it is possible to prevent the lead parts (102) acting as the terminals from peeling off in the side surface direction after the package is formed. However, the shape of the lead parts is not limited to that adopted in this application example. The lead part can also be formed with a tapered shape. The lead part can also be formed with a straight shape with a uniform width as long as the adhesion between the molding resin and the lead frame is good.

In addition, although not shown in the figure, positioning marks for setting the IC chip in the mounting part can also be formed on lead frame (100) at positions suitable for the functions of the terminals. In this way, dislocation of the IC chip can be prevented. Depending on these marks, the integrated circuit package can also be mounted on a card at a position suitable for the functions of the terminals.

The material of lead frame (100) used in the present invention can be any material that is generally used for lead frames. Examples include 42 alloy or another iron-type alloy, KLF-5 or another copper-type alloy, JIS SUS304, SUS316, SUS410, SUS430 or another stainless steel. It is preferred to use an austenitic stainless steel, such as SUS 304 or SUS 316, which has little magnetism that will induce malfunctions of the IC chip.

When an iron-type alloy or a copper-type alloy is used, it is desirable to form a gold plating layer, or a gold plating layer using a nickel plating layer as the primer, to prevent oxidation and corrosion of the surfaces acting as the terminal surfaces of lead parts (102), that is, the surface for setting the IC chip and the opposite surface. It is preferred to form a gold plating layer with high resistance to scratches as the outermost layer.

Figure 3 shows the cross section along line A-A in Figure 2.

The space (103) between lead part (102) and IC chip mounting part (101) is filled by the resin when the lead frame is sealed by the molding resin. It acts as an anchor for firmly adhering the resin and the lead frame to each other. Its shape has great influence on the adhesion between the resin and the lead frame. Also, although not shown in this figure, the space (104) between lead part (102) and lead part (102) (Figure 2) has the same function.

The lead frame shown in Figure 3 is manufactured by means of stamping. Space (103) has a straight shape. In order to increase the adhesive force, it is preferred to use a lead frame manufactured by means of etching. The spaces (103), (104) of a lead frame manufactured by means of two-sided etching, half etching, or another etching process can have various shapes depending on the etching method. Examples include a shape with a small opening part and two parts inside the lead frame with a larger cross-sectional area than the opening part (Figure 4(A)), a shape with a step inside such that there is a large opening part on the terminal side and a small opening part on the IC chip side (Figure 4(B)), a shape with a large central part and small opening parts (Figure 4(C)), and a trapezoidal shape with a large opening part on the terminal side as shown in Figure 5. In all of these cases, since the molding resin filling the space when the lead frame is sealed by the molding resin acts as an anchor, the entire molding resin will not come off from the lead frame easily, and the adhesion between the lead frame and the molding resin can be improved to prevent the terminals from peeling off. Such a design also has an effect of reinforcing the molding resin against bending. It would be better if the aforementioned cross-sectional shape could be adopted not only for spaces (103), (104) but also for the cross section of the entire lead frame. When the bumps and dips (105) shown in Figures 4 and 5 are formed on the surfaces of IC chip mounting part (101) and lead parts (102), the contact area between the lead frame, the molding resin, and insulator is increased. Also, since these bumps and dips act as anchors, the adhesion between the lead frame and the molding resin as well as the adhesion with the insulator can be further improved. In the present invention, it is preferred to change the shape of the bumps and dips according to the molding resin used. However, these bumps and dips can be omitted if the adhesion between the molding resin or the insulator and the lead frame is good, especially when they are not needed.

These bumps and dips can be formed using either a physical method, for example, by sand blasting the lead frame or by using a chemical method such as etching.

The concave part (106) for embedding the insulator or the insulator and the IC chip as shown in Figure 6 can be formed on the lead frame used in the present invention. Said concave part (106) can be formed by means of etching or using an end mill. In this way, the thickness of the entire integrated circuit package can be reduced, and it is easy to form an integrated circuit package that satisfies the specification. Also, since the molding resin can fill in concave part (106), the thickness of the resin layer can be increased by comparison to the lead frame with no concave part. Conversely, since the thickness of the lead frame itself, except for the concave part, can be increased, the strength of the integrated circuit package itself can be increased.

Electrically insulating sheet, film, etc., can be used as insulator (1) in the present invention. Examples include films or sheets made of polyimide, glass epoxy, glass fibers, BT resin, Teflon, polyester, ceramic, etc. Instead of using sheet or film, it is also possible to coat the back side of the IC chip or the surface of the lead frame with an insulating resin to form an insulating layer.

In the present invention, since insulator (1) covers IC chip mounting part (101) and parts of terminal lead parts (102), even if a large IC chip is used that sticks out from mounting part (101) and overhangs terminal lead parts (102), the IC chip and the terminal lead part will not be electrically connected to each other. Also, since insulator (1) is arranged as described above, it can reinforce the resin parts in spaces (103), (104) that are weak against bending. The insulator acts as a reinforcing part so that terminals (102) will not peel off or separate and the resin parts in spaces (103), (104) will not develop cracks even when the package is bent.

When using insulator (1) as the reinforcing part as described above, its thickness is preferred to be in the range of 0.05-0.2 mm. From the point of view of insulation, a thickness in the range of 0.01-0.05 mm is sufficient.

It is also possible to form an adhesive layer between insulator (1) and lead frame (100) and IC chip (2). Examples of the adhesives that can be used include epoxy resin adhesives, melamine resin adhesives, polyester polyisocyanate adhesives, and other thermosetting adhesives, polyvinyl acetate adhesives, vinyl acetate/vinyl chloride copolymer adhesives, acrylic resin adhesives, cyanoacrylate adhesives, polyamide resin adhesives, and other thermoplastic adhesives, nitrile rubber adhesives, polychloroprene adhesives, SBR adhesives and other rubber type adhesives, rubber type binding agents, acrylic binding agents, and their composite adhesives, etc. The adhesive layer can be formed by coating the lead frame or IC chip with the aforementioned adhesives using a conventional coating method. Of course, it is also possible to coat the adhesives on the insulator or impregnate the insulator with the adhesives.

The ordinary molding resins can be used in the present invention. Examples include epoxy resins, silicone resins, epoxy/silicone hybrid resins, etc.

Figure 8 is a plan view illustrating a lead frame that is further reinforced against bending.

The lead frame has parts (110), (111), (112), (113) for reinforcing against bending. Depending on the reinforcing parts, the spaces (103) and (104) of the lead frame will not come into contact with the ends of the lead frame in a linear form and can be reinforced against bending. For example, when the lead frame shown in the figure is bent in the left and right directions, spaces (103) are reinforced by (110) and (112) so that no cracks occur in spaces (103). Similarly, spaces (104) are reinforced by (111), (113) against bending in the vertical direction. Of course, the strength of the entire package is also increased. The cross section of the lead frame can be formed with the aforementioned shape, and said concave part (106) (the part encircled by the dot-dash line in the figure) used for embedding the insulator or the insulator and the IC chip can be formed on the lead frame. In that case, the aforementioned effect can be realized.

When the lead frame is sealed by the molding resin in a square shape as indicated by broken line (107), processing for manufacturing the package and processing for mounting the package on a card can be facilitated.

Also, (120) in the figure is an example of the aforementioned positioning mark. It is arranged integrally with the lead frame when manufacturing the lead frame.

Figure 9 is the plan view of an IC card (30), wherein the integrated circuit package (10) of the present invention using the lead frame shown in Figure 8 is assembled in plastic card base material (20). Figure 10 is the cross section along line B-B.

Integrated circuit package (10) is embedded in a concave part formed in a prescribed area of card base material (20) in such a way that the terminal side of the integrated circuit package is on the same side as the surface of card base material (20). The integrated circuit package is fixed firmly using an adhesive (21). Said card base material (20) may also have magnetic strips, holograms, embossing, a photo of a person's face formed by engraving, or patterns, logos, barcodes, notes, designs, etc., formed by means of general printing.

When this card is inserted into a prescribed card processor, signals can be transferred between the card processor and the integrated circuit via terminals (102) to process the information.

Besides being used for cards, the integrated circuit package of the present invention can also be used for other integrated circuits that require high assembly density.

#### Effects of the invention

Since an insulator is arranged between the lead frame and the IC chip in the integrated circuit package of the present invention, even if the IC chip is large and overhangs the lead part acting as the terminal, the IC chip and the lead frame will not be electrically connected to each

other. Therefore, any multi-functional large-capacity IC chip can be used to provide an IC card with high reliability.

The insulator used in the present invention can also act as a reinforcing part for reinforcing the resin parts in spaces (103), (104) that are weak against bending. The insulator can also prevent terminal lead parts (102) from peeling or falling off. The integrated circuit package of the present invention has good strength against bending.

When a lead frame having the reinforcing part disclosed in a preferred embodiment of the present invention is used, the strength against bending can be further improved.

When a lead frame is used having the concave part, used for embedding the insulator or the insulator and the IC chip, disclosed in a preferred embodiment of the present invention, the thickness of the entire integrated circuit package can be reduced, while conversely the thickness of the lead frame itself, except for the concave part, can be increased. Therefore the strength of the integrated circuit package itself can be increased.

In the following, the present invention will be explained in more detail with reference to application examples.

### Application Example 1

A 42 alloy sheet 0.21 mm thick was stamped to form a lead frame having 6 lead frames for package units with a size of 20 mm x 20 mm and having 8 lead terminals, as shown in Figure 2.

After 5- $\mu$ m-thick Ni was plated on the terminal side of the formed lead frame, 1- $\mu$ m-thick hard Au was plated. Then, 0.5- $\mu$ m-thick soft Au was plated only in the bonding area on the side where the IC chip was to be placed. As a result, a plated lead frame was obtained.

Then, an 80- $\mu$ m-thick polyimide sheet (commodity name: Polyimide Tape JR-2250 for fixing lead frames, manufactured by Nitto Electric Industrial Co., Ltd.), with a thermosetting adhesive coated on one side, was bonded by heating at 150°C to the position (106) shown in Figure 2 on the side of the lead frame where the IC chip was to be placed, to form an insulator or the lead frame.

A thermosetting epoxy die adhesive was then applied to a thickness of 20  $\mu$ m in the chip die part on the aforementioned insulator. An IC chip was placed on the lead frame via this adhesive layer.

The IC chip bonding part and the terminal part of the soft gold-plated lead frame were then connected to each other by a wire bonding machine using gold wires with a diameter of 25  $\mu$ m.

The connected IC chip and the lead frame were then sealed on one side by an epoxy type transfer molding resin (commodity name: MP-10, produced by Nitto Electric Industrial Co.,

Ltd.) by means of transfer molding. After that, the lead frame was cut at the prescribed positions of the package units. If necessary, the resin surface was ground to obtain the integrated circuit package of the present invention with a thickness of 0.7 mm.

The integrated circuit package obtained functions well, and there are no cracks in the resin surface even when the package is bent.

### Application Example 2

A 0.27-mm-thick 42 alloy sheet was prepared. After it was rinsed and dried according to the conventional method, a photoresist was coated and dried on both sides of the alloy sheet to form a photosensitive film in a prescribed thickness. A lead frame plate having 6 lead frames for package units with a size of 20 mm x 20 mm and having 8 lead terminals, as shown in Figure 2, was then exposed and developed according to the conventional method, followed by two-side etching and half etching. As a result, each cross-sectional surface of the lead frame was formed into the shape shown in Figure 4(B), and a 0.17-mm-deep concave part for embedding the insulator was formed at position (106), shown in Figure 2, with a size that covered the IC chip mounting part and the lead terminal parts.

Plating was then carried out in the same way as described in Application Example 1.

Then, on the bottom of the concave part for embedding the insulator, an 80- $\mu\text{m}$ -thick polyimide sheet (commodity name: Polyimide Tape JR-2250 for fixing lead frames, produced by Nitto Electric Industrial Co., Ltd.) with a thermosetting adhesive coated on one side was bonded by heating at 150°C to the position (106), shown in Figure 2, to form an insulator on the lead frame.

Subsequently, wire connection and mold resin sealing were carried out in the same way as described in Application Example 1 to obtain the integrated circuit package of the present invention with a thickness of 0.6 mm.

The integrated circuit package obtained functions well, and there are no cracks in the resin surface even when the package is bent. Also, the terminals do not peel off.

### Application Example 3

A 0.27-mm-thick 42 alloy sheet was prepared. After it was rinsed and dried according to the conventional method, a photoresist was coated and dried on both sides of the alloy sheet to form a photosensitive film in a prescribed thickness. Then, a lead frame plate having 6 lead frames of package unit in a size of 20 mm x 20 mm and having 6 lead terminals as well as the reinforcing parts shown in Figure 8 was exposed and developed according to the conventional method, followed by two-side etching and half etching. As a result, each cross-sectional surface of the lead frame was formed into the shape shown in Figure 4(B), and a 0.17-mm-deep concave

part for embedding the insulator was formed at position (106), shown in Figure 8, with a size that covered the IC chip mounting part and the lead terminal parts.

Plating, IC chip setting, wire connection, and mold resin sealing were then carried out in the same way as described in Application Example 2 to obtain the integrated circuit package of the present invention with a thickness of 0.6 mm.

The integrated circuit package obtained functions well, and there are no cracks in the resin surface even when the package is bent. Also, the terminals do not peel off.

#### Application Example 4

An IC chip was inner-bonded to a tape carrier having fingers for inner and outer leads and using a polyimide film as the base. An epoxy resin was then coated to a thickness of 60  $\mu\text{m}$  to protect the IC circuit on the inner bonding surface and to planarize the surface. After the tape carrier and the IC chip were integrated, it was cut with the fingers for outer leads left. As a result, an IC chip was obtained that can be set in a lead frame.

The lead frame used for the obtained IC chip was the same as that used in Application Example 3. On the bottom of the concave part for embedding the insulator, an 80- $\mu\text{m}$ -thick polyimide sheet (commodity name: Polyimide Tape JR-2250 for fixing lead frames, produced by Nitto Electric Industrial Co., Ltd.) with a thermosetting adhesive coated on one side was bonded by heating at 150°C to the position (106), shown in Figure 8, on the side of the lead frame where the IC chip was to be placed to form an insulator on the lead frame.

Then, the fingers for outer leads were bonded to the bonding area of the plated lead frame to connect the IC chip to the lead frame.

The connected and integrated IC chip and lead frame were then sealed by a molding resin, in the same way as described in Application Example 3, to obtain the integrated circuit package of the present invention with a thickness of 0.55 mm.

The obtained integrated circuit package functions well, and there are no cracks in the resin surface even when the package is bent. Also, the terminals do not peel off.

#### Brief description of the figures

Figure 1 is a partially cut-away oblique view illustrating an example of the integrated circuit package disclosed in the present invention. Figures 2 and 8 are plan views illustrating the lead frame used in the present invention. Figure 3 is the cross section along line A-A in Figure 2. Figures 4, 5, and 6 are cross sections illustrating the other lead frames used in the present invention. Figure 7 is a cross section illustrating another example of the integrated circuit package disclosed in the present invention. Figure 9 is a plan view illustrating an example of the

IC card into which the integrated circuit package of the present invention is assembled. Figure 10 is the cross section along line B-B in Figure 9.

1	Insulator
2	IC chip
4	Molding resin
10	Integrated circuit package
30	IC card
100	Lead frame
101	IC chip mounting part
102	Lead part
103, 104	Spaces between lead frames
106	Concave part

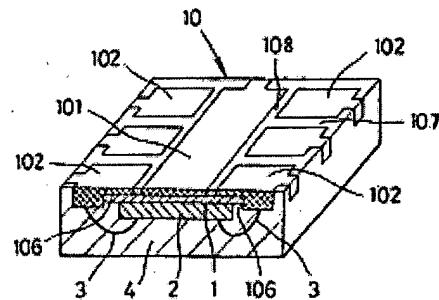


Figure 1

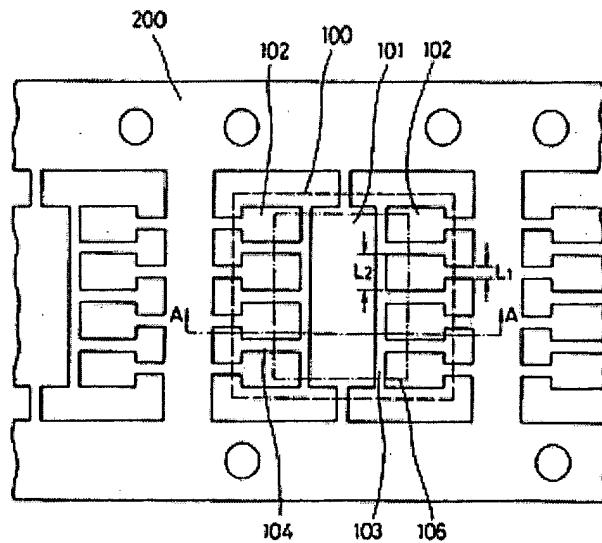


Figure 2

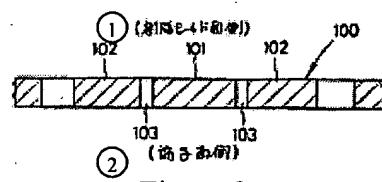


Figure 3

Key: 1 (Resin mold side)  
2 (Terminal side)

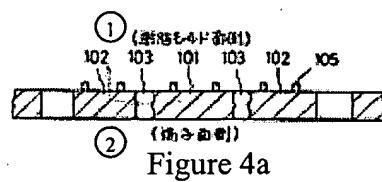


Figure 4a

Key: 1 (Resin mold side)  
2 (Terminal side)

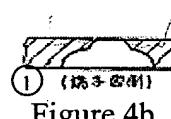


Figure 4b

Key: 1 (Terminal side)



Figure 4c

Key: 1 (Terminal side)

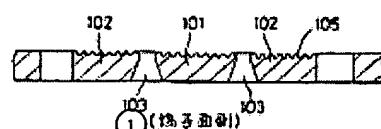


Figure 5

Key: 1 (Terminal side)

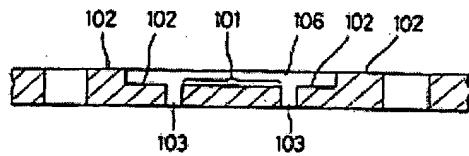


Figure 6

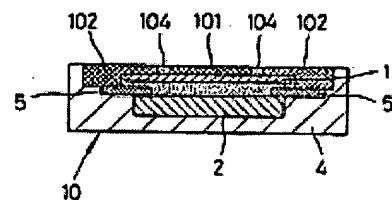


Figure 7

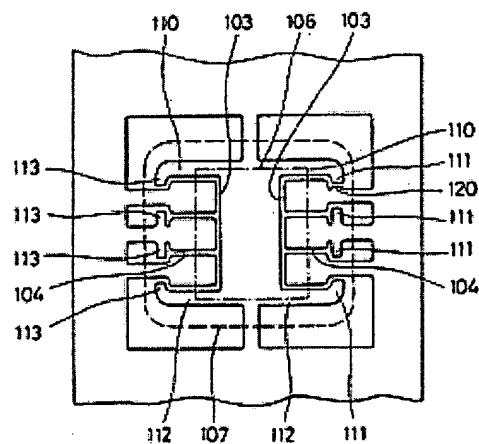


Figure 8

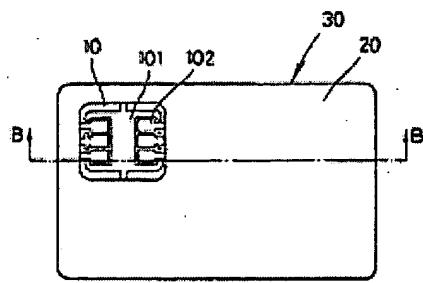


Figure 9

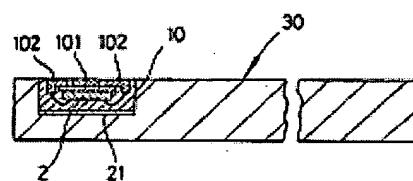


Figure 10